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Is Major Depression Linked to Alcohol-Impaired Driving?

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Abstract

Background: Alcohol-impaired driving causes a substantial proportion of motor vehicle accidents. Depression is a prevalent psychiatric disorder among drinker-drivers. Few previous studies have investigated the relationship between major depression and alcohol-impaired driving.

Objectives: We investigated whether depression has a positive relationship with the probability of alcohol-impaired driving after controlling for the co-occurrence of binge drinking and alcohol dependence.

Methods: Our data consisted of drinkers aged 21–64 from two waves of the National Epidemiologic Survey of Alcohol and Related Conditions (NESARC). Cross-sectional analysis investigated whether depression is an independent risk factor for drinking-driving. Longitudinal analysis distinguished the relationship of depression onset, continuance, and recovery with changes in drinking-driving behaviors between the waves. These dual approaches allowed comparisons with previous studies.

Results: Major depression was a small but statistically significant predictor of changes in alcohol-impaired driving behaviors among men but not women. Binge drinking and alcohol dependence were comparatively stronger predictors.

Conclusions/Importance: There is limited empirical support that treating depression reduces drinking and driving in men who do not exhibit symptoms of alcohol use disorders. For persons for whom depression and alcohol use disorders co-occur, treating depression should be part of a strategy for treating alcohol use disorders which are highly related to drinking and driving.

Keywords

alcohol-impaired driving; depression; binge drinking; alcohol use disorder (AUD); National Epidemiological Survey of Alcohol and Related Conditions (NESARC)

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Declaration of interest

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INTRODUCTION

; Conner, Pinquart, & Gamble, 2009; Sarsour et al., 2012). The combination of alcohol use with depression may adversely affect psychomotor performance, increasing the risk of a collision (Stoduto et al., 2008). Although the relationship between depression and alcohol use is well-established, it is not known whether depression is an independent risk factor for alcohol-impaired driving.

Our study used panel data from two waves of a large, nationally representative survey of the U.S. population, the National Epidemiologic Survey of Alcohol and Related Conditions (NESARC), to assess the relationship between major depression and alcohol-impaired driving. This study makes several contributions. First, given availability of valid and reliable measures of depression, alcohol dependence, and a rich set of variables on alcohol consumption, we could distinguish among three pathways through which depression influences drinking and driving: behavioral manifestations of depression; heavy alcohol consumption (binge drinking); and alcohol dependence. Being able to make these distinctions, we could ascertain whether behavioral manifestations of depression have an independent role in explaining variation in drinking and driving activity over and above the influences on heavy alcohol consumption and alcohol dependence. Second, the longitudinal aspect of the NESARC allowed us to account for the fact that depression is a chronic and episodic disorder (Kessler, McGonagle, Swartz, Blazer, & Nelson, 1993; Kessler, Zhao, Blazer, & Swartz, 1997b), and for unobserved heterogeneity among individuals. Previous studies on the topic have been cross-sectional (Stoduto et al., 2008; Zhang & Sloan, 2014), and hence could not offer insight into how changes in alcohol-impaired driving behavior might reflect changes in depression over time. Third, because we use both cross-sectional and longitudinal analysis, our results can be compared to previous studies that solely used cross-sectional analysis. Fourth, to the best of our knowledge, our study is the first to assess the link between depression and alcohol-impaired driving while controlling for alcohol use disorders (AUDs). The NESARC contains valid and reliable measures for depression, AUDs, and alcohol-impaired driving behaviors in a single data source.

We found: (1) some evidence for a separate statistically significant role, albeit small in magnitude, for the behavioral manifestations of depression other than through co-occurring alcohol dependence and binge drinking in men but no such role for depression in women; (2) a co-occurring alcohol dependence pathway linking clinical indicators of depression to drinking and driving; (3) and a role for binge drinking as an independent risk factor for drinking and driving.

Background and Previous Literature

Several underlying mechanisms explain the positive association between depression and drinking and driving—comorbidity and behavioral manifestations of depression. Depression and AUD frequently co-occur (Gilman & Abraham, 2001; Grant & Harford, 1995; Grant et al., 2004; Hasin, Stinson, Ogburn, & Grant, 2007; Kessler et al., 1994, 1997a, 2005; Kuo, Gardner, Kendler, & Prescott, 2006; Lapham et al., 2001, 2006; Sullivan, Fiellin, & O'Connor, 2005). AUD encompasses alcohol abuse (Diagnostic and Statistical Manual of

Mental Disorders, Fourth Edition (DSM-IV), 305.00) and dependence (303.90). Having an AUD predicts alcohol consumption and drinking and driving (Marcus et al., 2005). Self-medicating with alcohol to cope with a depressed mood may increase alcohol consumption and lead to binge drinking (Cerdeira, Tracy, & Galea, 2011; Sloan, Reilly, & Schenzler, 1995). Previous research on the relationship between depressed mood and drinking and driving has included alcohol consumption measures (Stoduto et al., 2008), but with no distinction made between pathologic drinking behavior and general alcohol consumption.

In addition to general effects of AUD, two specific decisions are most relevant to choice to drink and drive: (1) the decision not to engage in heavy drinking when driving is anticipated, either by drinking in locations where driving is more likely to be unnecessary, such as at home or by drinking less when driving is anticipated; and (2) conditional on having engaged in heavy drinking at a location at which driving is necessary, obtaining a non-intoxicated driver to transport the individual to another location—either a paid (e.g., taxi) or unpaid method of transportation (e.g., designated driver).

Depressive symptoms may weaken an individual's ability for self-control, which makes limiting the amount of alcohol consumption in anticipation of driving and obtaining a designated driver more challenging (Baumeister, Zell, & Tice, 2011). Self-control becomes more difficult when the individual is distressed emotionally, either (1) because guilt makes the person feel he or she should suffer a negative outcome, (2) emotional distress makes it more difficult to think rationally about advantages and disadvantages of alternative courses of action, and/or (3) being distressed may undermine the person's motivation to think rationally (Baumeister et al., 2011; Tice, Bratslavsky, & Baumeister, 2001). Heavy drinking may make the individual more present oriented, placing more emphasis on immediate benefits of heavy drinking rather than about adverse consequences of drinking and driving and driving even though accidents and arrests may occur soon there after (Steele & Josephs, 1988; Amlung et al., 2016). Being more present-oriented may make individuals more likely to focus on continued drinking and less on obtaining a designated driver. Individuals may use risky forms of behavior to find relief from negative states, e.g., gambling for mood modification (Ciccarelli, Griffiths, Nigro, & Cosenza, 2017). Low self-esteem may reduce friendships and interpersonal interactions making it more difficult for individuals with major depression to obtain a designated driver (Baumeister, Campbell, Krueger, & Vohs, 2003). Social withdrawal and low self-worth impair willingness and ability to seek help (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961), e.g., obtaining a designated driver (Zhang and Sloan, 2014), but also affect where drinking occurs--more likely to occur in an isolated situation which makes drinking and driving less likely.

MATERIALS AND METHODS

Data

Our analysis used two waves of NESARC data collected in 2001–2 and 2004–5. NESARC surveyed 43,093 individuals in wave 1. African-Americans, Hispanics, and persons aged 18–24 were oversampled. Wave 2 re-interviewed all persons from wave 1 except for those ineligible due to death, emigration, active military duty, or physical or mental incapacity, or those refusing a second interview. There were 34,653 completed wave 2 interviews. Our

study included persons 21–64 who consumed alcohol during the year before wave 1 or the year before wave 2.

The NESARC has been used to study the bi-directional relationships between AUDs and depressive disorders (Pacek, Martins, & Crum, 2013), early adverse life events and AUDs (Fetznier, McMillan, Sareen, & Asmundson, 2011), self-medication of mood disorders with alcohol (Bolton, Robinson, & Sareen, 2009), depression as a co-morbidity of AUDs (Cranford, Nolen-Hoeksema, & Zucker, 2011), socioeconomic correlates of depressive disorders (Rubio et al., 2011), AUD severity as a predictor of depression onset (Boschloo, van den Brink, Penninx, Wall, & Hasin, 2012), and relationships between personality disorders, alcohol use, and alcohol-impaired driving (Maclean & French, 2014).

Empirical Specification

Sample Stratification—Analysis was conducted separately for males and females. Males on average consume larger amounts of alcohol (e.g., Blazer & Wu, 2009; Rehm & Shields, 2013) and rates of alcohol-impaired driving are higher for males (e.g., Schwartz & Rookey, 2008). Depression, conversely, is more common among females (e.g., Kessler et al., 1993).

Measurements of Alcohol-Impaired Driving—We used three different measures of alcohol-impaired driving behaviors. The dependent variables were based on responses to these questions: (1) “How often did you drive a motor vehicle after having 3+ drinks in the last 12 months?” Response categories with assumed number of days in parentheses were: daily (365); nearly every day (assumed to be 5 times a week, $260=52*5$); 3–4 times weekly ($182=52*3.5$); once weekly (52); 2–3 times monthly ($30=12*2.5$); once a month (12); 7–11 times (9); 3–6 times (4.5); 1–2 times in last year (1.5); and never (0). (2) “Did you more than once drive a vehicle after having too much drink?” (3) “Did you more than once drive a vehicle WHILE drinking?” (capitalization shown in survey). The timeframe for both the second and third questions was also the year before the survey. “Drinking while driving” was defined for survey respondents as either driving with an open container or consuming alcohol sometime during the trip, e.g., at a gas station.

In our cross-sectional analysis, dependent variables were measured in levels at wave 1. The frequency of driving after having 3+ drinks was coded as a count variable. Variables based on the second and third questions were coded as binary variables, with 1 indicating an affirmative response. In the longitudinal analysis, dependent variables represented changes in levels for each question between the two waves; we subtracted the wave 1 value from its wave 2 counterpart. The range of values for differences in the binary variables, driving after drinking too much and drinking while driving, was –1 to 1; e.g., if a person reported any drinking while driving at wave 1 but none at wave 2, the value for “change in drinking while driving” took a value of –1.

Measurement of Major Depression—The key explanatory variable in the cross-sectional analysis was a binary variable for major depression based on symptoms reported by the respondent in the year before the interview. The NESARC’s measure of major depression used the Alcohol Use Disorder and Associated Disabilities Interview Schedule-DSM-IV version (AUDADIS-IV). This is a structured interview designed to measure

psychiatric disorders and associated conditions in large-scale surveys (Grant, Harford, Dawson, Chou, & Pickering, 1995; Grant et al., 2003). Both the validity and reliability of AUDADIS-IV are documented (Dawson, 2006). A diagnosis of major depression requires the presence of five or more depressive symptoms (including depressed mood or loss of pleasure and interest) that persist for most of the day, nearly daily, over at least two weeks. Social and/or occupational dysfunction must accompany the depressive episode. NESARC excluded cases in which depressive symptoms stemmed solely from bereavement or physical illness. The definition of major depression used here has been widely used in previous studies of depression using NESARC data (e.g., Grant & Harford, 1995; Hasin, Goodwin, Stinson, & Grant, 2005; Hasin et al., 2007; Grant et al., 2008; Cranford et al., 2011).

Key covariates in the longitudinal analysis were three binary variables indicating depression status between waves: (1) depression onset; (2) continuing depression; (3) depression recovery; and (4) no depression in either wave, the omitted reference group. Onset meant not having a sufficient number of symptoms at wave 1 to be classified as depressed but having a sufficient number at wave 2, and conversely for recovery. "Continuing depression" indicates the respondent was depressed in both waves.

Measurements of Binge Drinking and Alcohol Dependence—We controlled for binge drinking and alcohol dependence as co-occurring AUDs. We included a covariate for binge drinkers rather than alcohol abuse because the DSM-IV criteria for alcohol abuse include alcohol-impaired driving. The binge drinker indicator was 1 for men consuming 5+ drinks on one occasion and for women consuming 4+ drinks on one occasion during the year before the interview (Wechsler & Austin, 1998; Wechsler & Nelson, 2001; Naimi et al., 2003; Naimi, Nelson, & Brewer, 2010; Brewer & Swahn, 2005). Alcohol dependence was measured by AUDADIS-IV. A person was considered alcohol dependent if s/he satisfied at least three of seven criteria for dependence during the year before the interview.

We defined binary variables for binge drinkers in the cross-sectional analysis two alternative ways. When alcohol dependence was excluded as a covariate, binge drinker included all binge drinkers irrespective of alcohol dependence status. When alcohol dependence was included as a covariate, we excluded alcohol dependent persons from our definition of binge drinker (here after referred to as non-alcohol dependent, or non-AD binge drinkers). In the longitudinal analysis, the key covariates referred to *changes* in binge drinker and alcohol dependence status. For example, if a person was a binge drinker at wave 1 but not wave 2, the value for the covariate "change in binge drinker" was -1.

Other Respondent Attributes—In the cross-sectional analysis, we included covariates for age at wave 1; educational attainment measured by years of schooling completed; age person started drinking; African-American, Hispanic ethnicity, and other race, with Caucasian race as the omitted reference group. These time-invariant characteristics were omitted from the longitudinal analysis. Both the cross-sectional and longitudinal analyses included covariates for marital status; numbers of adults (age 18+) and children (<18) in household; a annual household income; and employment status as unemployed, not in labor force, or employed (omitted). In the cross-sectional analysis, these respondent attributes

were represented by wave 1 levels. In the longitudinal analysis, we coded variables showing the change in these attributes between waves.

Statistical Analysis

Overview

Marginal effects, the change in the value of the dependent variable per unit change in the explanatory variable evaluated at the observational means, were calculated for each respondent in the cross-sectional analysis based on mean values for the explanatory variables and associated parameter estimates. We used negative binomial regression when the dependent variable was the number of days in the past year on which the person drove after consuming 3+ drinks. Using a count rather than a set of ordered categories facilitated interpretation of the marginal effects of differences in depression status and other covariates on the dependent variable. We used logit analysis when the dependent variable was a binary indicating driving after drinking too much or drinking while driving.

In the longitudinal analysis, we recoded the dependent variables as categorical variables, where the three categories indicate a “decrease,” “no change,” or “increase” between waves for a given measure of alcohol-impaired driving. If a person drove after having 3+ drinks on fewer days in wave 2 than wave 1, the recoded categorical variable for change in frequency of days driving impaired was set to 1. If he/she drove the same number of days in both waves, the dependent variable was set to 2; if the behavior occurred on more days in wave 2 than wave 1, the dependent variable was set to 3. This simplification was necessary because NESARC used 10 mutually exclusive categories to measure number of days driving after having 3+ drinks, creating a multiplicity of possible response combinations for the two waves that would severely complicate interpretation if we had defined a separate category for each in the dependent variable. Parameters were estimated using ordered logit analysis. The change variable for driving after having too much to drink was a decrease if the person drove after having too much to drink in the year before wave 1 but not wave 2, no change if the person engaged in this behavior in year before both waves did not do this at both waves, and as an increase if the person did not drive after drinking too much in the year before wave 1 but did so before wave 2. This same method was applied to responses for drinking while driving for analysis of both driving after having had too much to drink. Both used ordered logit analysis.

We present three equation specifications: (1) explanatory variables for binge drinker and alcohol dependence excluded; (2) an explanatory variable for binge drinker included, irrespective of alcohol dependence status; and (3) explanatory variables for non-AD-binge drinker and alcohol dependence included. We examined the overall relationship between alcohol-impaired driving and depression in Specification I, this relationship after controlling for binge drinking in Specification II, and then again after controlling for both binge drinking and alcohol dependence in Specification III. By comparing results from the three specifications, we could determine whether depression has an independent role in an increased likelihood of alcohol-impaired driving.

Cross-Sectional Analysis

We first estimated cross-sectional equations of the following form using data from wave 1:

$$y_{it} = \alpha + \beta D_{it} + \varphi B_{it} + \theta A_{it} + \delta X_{it} + \gamma Z_i + \varepsilon_{it} \quad 1$$

In eq. (1), y_{it} measures alcohol-impaired driving behaviors; D_{it} is a binary variable for having major depression, the key parameter of interest; B_{it} and A_{it} represent being a binge drinker and being alcohol dependent; X_{it} is a vector of time-varying and Z_i of time-invariant respondent attributes; ε_{it} is the random error term.

Longitudinal Analysis

Using both waves of NESARC, we then estimated:

$$(y_{it+1} - y_{it}) = \beta_1' DO_{it+1} + \beta_2' DR_{it+1} + \beta_3' DC_{it+1} + \varphi'(B_{it+1} - B_{it}) + \theta'(A_{it+1} - A_{it}) + \delta'(X_{it+1} - X_{it}) + \psi_{it+1}$$

2

Where $(y_{it+1} - y_{it})$ is a categorical variable representing the change in a measure of alcohol-impaired driving between waves. DO_{it+1} and DR_{it+1} stand for major depression onset and major depression recovery between t and $t+1$, and DC_{it+1} for persons who were classified as having major depression at both waves (omitted reference group not having major depression at either wave). The parameters β' , φ' , θ' , and δ' measure effects of changes and continuity of major depression, being a binge drinker, being alcohol dependent, and other time-varying respondent attributes. The parameters β' indicate the extent to which changes in major depression are associated with changes in alcohol-impaired driving behavior *over and above* those caused by co-occurring binge drinking and alcohol dependence. A counter part to the parameter γ does not appear in eq. (2) since the time-invariant variables in Z_i were excluded from the longitudinal analysis.

All statistical analysis was performed with STATA 14. Estimates of variance were adjusted to allow for the NESARC's complex survey design.

RESULTS

Summary Statistics

Table 1 presents sample means and standard deviations for each variable used in the analysis. Nearly a quarter (24.6%) of males and a tenth (9.5%) of females drove at all after having 3+ drinks during the year before wave 1 (Panel A). The corresponding mean number of days in the past year on which this behavior occurred were 6.8 and 2.7, respectively. The probabilities of driving after drinking too much were considerably lower for both genders

than when the 3+ drinks threshold was used, which implies that many respondents who consumed 3+ drinks before driving did not think this was “too much.” Major depression was more common in females than in males (11.7% and 5.4%, respectively). Binge drinking at least once was common (44.5%, males; 29.0%, females). Satisfying the study’s criteria for alcohol dependence was much less common (6.9%, males, 3.7%, females).

Mean values of 0 for the change in number of days driving after having 3+ drinks (Panel B) indicate that about the same number of people increased their number of days driving impaired in wave 2 as decreased it (see footnote on Table 1 for specific percentages). Mean fractions of persons who drove after drinking “too much” rose slightly between the waves, while the fractions for drinking while driving decreased slightly. Only 1.2% of males and 4.1% of females exhibited symptoms satisfying the study’s criteria for major depression at both waves. The large majority (90.4%) of males and females (80.0%) satisfied these criteria at neither wave. Fractions of binge drinkers and alcohol dependent persons increased slightly between waves.

Cross-Sectional Regression Results

In Table 2, results from negative binomial and logit regressions are shown as marginal effects with associated standard errors. Excluding binge drinker and alcohol dependence (Specification I), major depression was positively and significantly associated with two of the three alcohol-impaired driving dependent variables for men (Table 2, Panel A), and almost significantly associated with the third, drinking while driving ($p=0.056$). Marginal effects were sizable relative to the observational means (presented above in Table 1). Men who were depressed drove after consuming 3+ drinks nearly 4 additional days in the past year. The probability of driving after drinking too much increased by 0.031 for the depressed group. The corresponding increase in the probability for drinking while driving was 0.029.

After adding the covariate for binge drinker (Specification II), marginal effects for major depression remained sizable. While there was little change in the magnitude of depression’s marginal effects for driving after drinking too much and drinking while driving ($p=0.066$) compared to Specification I, the change was larger for number of days driving after 3+ drinks and no longer statistically significant. After also controlling for alcohol dependence (Specification III), the relationship between major depression and alcohol-impaired driving disappeared.

The magnitudes of the marginal effects for major depression were systematically lower for females than males (Panel B). In Specification I, marginal effects for major depression were positive and statistically significant for driving after drinking too much and drinking while driving, but not for the number of days on which the woman drove after having consumed 3+ drinks. Results were robust to adding the binary variable for binge drinker (Specification II). In Specification III, marginal effects for depression again became insignificant after adding alcohol dependence.

Overall, marginal effects for major depression were relatively unaffected by controlling for binge drinking. But distinguishing alcohol dependent drinkers from non-alcohol dependent

binge drinkers greatly attenuated the positive relationship between alcohol-impaired driving and major depression.

Longitudinal Regression Results

Table 3 presents results for the change in the frequency of driving after having consumed 3+ drinks. For males in Specification I (Panel A), the onset of major depression was associated with a 7.8% lower chance that they would decrease their frequency of driving impaired between waves. Conversely, there was a 7.8% higher chance that men with depression onset would increase frequency of their impaired driving, relative to men who werenot depressed at either wave (the omitted group). Results for depression onset were quite robust to inclusion of covariates for changes in binge drinker and alcohol dependence status, implying that major depression is itself an important predictor of the frequency of alcohol-impaired driving for men.

Men with continuing depression or who recovered from depression were not any more likely to change how often they drove after having 3+ drinks than men who were never depressed, although the signs on marginal effects suggest a decrease in the frequency of driving impaired after recovering from depression, as one would expect. Marginal effects for changes in depression status tended to be smaller and less significant for women than for men (Panel B). Depression onset still had a statistically significant marginal effect in Specifications I, but not in Specifications II or III.

Table 4 presents results for the change in probability of driving after drinking too much. In contrast to Table 3 results, depression onset was only related to an increase in driving after drinking too much in Specification I (Panel A). Here, the marginal effects for males imply that recovering from depression leads to a decrease in the probability of driving after drinking too much as compared to never-depressed men in all three specifications. Given the lower magnitude in levels of and changes in Table 4's dependent variable (see Table 1), the marginal effects are correspondingly lower in absolute value than in Table 3. Even after controlling for binge drinker and alcohol dependence (Specification III), recovery from depression was associated with an increase in the probability that a person who drank and drove at wave 1 no longer reported doing so at wave 2 (1.5%), and a decrease in the probability that someone who didnt drink and drive before began doing so (−2.1%). Marginal effects for continued depression were statistically insignificant, showing no meaningful difference in changes in the probability of driving after drinking too much, compared to men who were never depressed.

For females, onset of major depression led to higher probabilities of increasing and lower probabilities of decreasing alcohol-impaired driving in Specifications I and II, but not in Specification III (Panel B). Unlike males, recovery from depression had no statistically significant relationship to changes in the dependent variable among females. Marginal effects were lower for females than males.

Table 5 presents results for the change in probability of drinking while driving. For men, the marginal effects again imply that recovery from major depression led to a decreased probability of drinking while driving in Specifications I and II; in Specification III they are

almost significant (p-values of 0.054 and 0.056) for decreased and increased drinking while driving categories, respectively. There were no significant marginal effects of depression among females (Panel B).

In Tables 3 through 5, marginal effects for continuing depression on changes in the probability of engaging in alcohol-impaired driving behaviors were statistically insignificant across the board. There was no substantial difference in changing driving behaviors between people with major depression at both waves and people who were never depressed. Explanatory variables capturing changes in binge drinker status and alcohol dependence were consistently and highly significant across all specifications, as previous literature would suggest.

Sensitivity Analysis

We conducted two robustness checks (not shown). First, we ran the cross-sectional analysis with data from wave 2 instead of wave 1. Although there were differences in the coefficients and a few differences in statistical significance, the implications of the analysis were the same. Second, we included non-drinkers in both the cross-sectional and longitudinal analyses. The sample became substantially larger, but results were similar to those presented.

DISCUSSION

From the longitudinal analysis of men, we found some evidence that becoming depressed or recovery from depression influences drinking and driving behavior after accounting for non-alcohol dependent binge drinking and alcohol dependence. Our cross sectional evidence for men did not support this conclusion, but the link between depression and drinking and driving was better identified with the longitudinal analysis. The longitudinal analysis accounted for changes in depression status. Persons with chronic depression are subject to substantial swings in depressed status, and cross-sectional data cannot capture this. There also may be physiological differences among individuals who experience a single episode of depression, repeat episodes, and those who never experience depression (Keller, Shapiro, Lavori, & Wolfe, 1982).

Major depression was far more common among women than among men, while drinking and driving behaviors and binge drinking and alcohol dependence were far higher among men. In contrast to men, the results for women provide no empirical support for a link between depression and drinking and driving except through AUD. Gender differences in response to depression reported in this study are consistent with findings from previous studies that women are more likely to exhibit internalizing symptoms from stress, such as somatization and changes in mood while men under stress are more likely to exhibit externalizing symptoms, such as aggressive behavior, substance use, and as in our study, driving under the influence of alcohol (Aneshensel, Rutter, & Lachenbruch, 1991; Conger, Lorenz, Elder, & Ge, 1993; Slopen, Williams, Fitzmaurice, & Gilman, 2011; Hasin & Grant, 2015).

We conducted cross-sectional analysis for comparison purposes. In our study, marginal effects of major depression on drinking and driving behaviors were statistically significant and mostly not affected by inclusion of the covariate for non-alcohol dependent binge drinker, which is consistent with Stoduto et al. (2008)'s findings. However, after distinguishing alcohol dependence from non-alcohol dependent binge drinkers, relationships between drinking and driving behaviors and major depression disappeared, which is consistent with Zhang and Sloan (2014)'s cross sectional analysis of other data. They found no relationship between depression and drinking and driving.

Co-occurring alcohol dependence is a more important pathway to drinking and driving than heavy (binge) drinking. Our results for depression were fairly robust to inclusion of binge drinker status in both longitudinal and cross-sectional analysis, but both the statistical significance and magnitude of depression's effect declined after covariates for alcohol dependence and non-alcohol dependent binge drinker were included in the same analysis.

Major strengths of our study are its longitudinal analyses and the data used. There may be underlying physiological differences between individuals who experience an isolated episode of depression, repeat episodes, and those who never experience depression (Keller, et al., 1982). Longitudinal analysis allowed us to account for time-invariant unobserved heterogeneity in individuals and also for episodic manifestations of depression over time. Our source data comes from a large, nationally representative sample with valid, reliable, and widely-used measures of major depression, binge drinking, and alcohol dependence. While many studies have been published using wave 1 NESARC data, longitudinal analyses of wave 1 and 2 data have been rare (Caetano, 2015). Comparisons between cross-sectional and longitudinal results and sensitivity analyses added empirical support to our overall findings.

We acknowledge several study limitations. We are unsure why the onset of depression was sometimes more impactful than recovery, or vice versa. Although the survey questions referred to the same time period (the year before the interview), we cannot know the extent to which days with depressed mood overlapped days on which alcohol-impaired driving occurred. If NESARC had used a shorter look-back period, such as a week or month, it would have been more likely that depressed mood and alcohol-impaired driving occurred on the same day; however, this also would have cost us substantially in terms of statistical power. Using indicators for decreased, increased, and no change in alcohol-impaired driving in the longitudinal analysis simplified interpretation of results but obscured information obtained on the magnitude of marginal effects, especially for our measure of number of days driving after having 3+ drinks.

An important implication of our results is that treating depression is not likely to be an effective intervention for curbing drinking and driving in the absence of indications of comorbid alcohol use disorders in women and to a limited extent in men. Treatment for depression should be part of treating alcohol use disorders which are highly related to drinking and driving.

Glossary

Alcohol use disorders (AUD): In the Diagnostic Statistical Manual IV (DSM-IV), which was used by NESARC, AUD consists of alcohol abuse and alcohol dependence. For the latter concept, see below. A person was said to have abused alcohol if the person answered affirmatively to any of these four questions. In the past year, have you: (1) found that drinking—or being sick from drinking—often interfered with taking care of your home or family? Or caused job troubles? Or school problems? (2) more than once gotten into situations while or after drinking that increased your chances of getting hurt (such as driving, swimming, using machinery, walking in a dangerous area, or having unsafe sex)? (3) more than once gotten arrested, been held at a police station, or had other legal problems because of your drinking? (4) continued to drink even though it was causing trouble with your family or friends?

Alcohol dependence: Using DSM-IV criteria, affirmative answers to any three of these questions indicates alcohol dependence. In the past year, have you: (1) had to drink much more than you once did to get the effect you want? Or found that your usual number of drinks had much less effect than before? (2) found that when the effects of alcohol were wearing off, you had withdrawal symptoms, such as trouble sleeping, shakiness, restlessness, nausea, sweating, a racing heart, or a seizure? Or sensed things that were not there? (3) had times when you ended up drinking more, or longer, than you intended? (4) more than once wanted to cut down or stop drinking, or tried to, but couldn't? (5) spent a lot of time drinking? Or being sick or getting over other aftereffects? (6) given up or cut back on activities that were important or interesting to you, or gave you pleasure, in order to drink? (7) continued to drink even though it was making you feel depressed or anxious or adding to another health problem? Or after having had a memory blackout?

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Table 1.**Descriptive Statistics**

Panel A. Cross-Sectional Analysis				
	Males (N=8,633)		Females (N=9,872)	
	Mean	Std. Dev.	Mean	Std. Dev.
Measures of Drinking and Driving				
No. days driving after having 3+ drinks	6.754	34.96	2.719	25.57
Any days driving after having 3+ drinks	0.246	0.43	0.095	0.29
Driving after drinking too much (binary)	0.066	0.25	0.025	0.16
Drinking while driving (binary)	0.103	0.30	0.038	0.19
Depression and AUDs				
Major depression	0.054	0.23	0.117	0.32
Binge drinker	0.447	0.50	0.297	0.46
Alcohol dependence	0.069	0.25	0.037	0.19
Non-alcohol dependent (AD) binge drinker	0.385	0.49	0.263	0.44
Respondent Attributes				
Age	40.309	11.62	40.089	11.58
Educational attainment (years)	13.944	2.87	14.076	2.72
Caucasian ^{\$}	0.739	0.44	0.772	0.42
African-American	0.091	0.29	0.101	0.30
Hispanic	0.126	0.33	0.096	0.29
Other race	0.044	0.20	0.031	0.17
Age started drinking	18.412	4.07	19.887	5.25
Married	0.637	0.48	0.616	0.49
No. adults in HH (18+)	2.143	0.89	2.022	0.80
No. children in HH (<18)	0.832	1.14	0.927	1.15
Household income (\$1000s)	66.202	63.52	63.804	79.99
Employed ^{\$}	0.865	0.34	0.758	0.43
Unemployed	0.037	0.19	0.035	0.18
Not in labor force	0.077	0.27	0.182	0.39
Panel B. Longitudinal Analysis [†]				
	Males		Females	
Measures of Drinking and Driving				
No. days driving after having 3+ drinks	0.000	0.56	0.000	0.37
Driving after drinking too much	0.017	0.32	0.008	0.21
Drinking while driving	−0.003	0.34	−0.001	0.24
Depression and AUDs				
Major depression: onset	0.042	0.20	0.083	0.28
Major depression: continuing	0.012	0.11	0.041	0.20

Major depression: recovery	0.042	0.20	0.076	0.26
Major depression: never ^{\$}	0.904	0.29	0.800	0.40
Binge drinker	0.019	0.50	0.023	0.47
Alcohol dependence	0.011	0.31	0.004	0.23
Non-alcohol dependent binge drinker	0.006	0.54	0.020	0.49
Respondent Attributes				
Married	0.024	0.30	0.014	0.31
No. adults in HH (18+)	0.048	0.90	0.054	0.85
No. children in HH (<18)	-0.115	0.87	-0.110	0.80
Household income (\$1000s)	7.101	60.52	4.460	71.06
Unemployed	0.000	0.25	0.002	0.25
Not in labor force	0.014	0.31	0.020	0.40

[†] Variables indicate the NESARC wave 1 value subtracted from the wave 2 value. Changes in all dependent variables and other binary variables have the range of values -1, 0, 1. Major depression measures are all binary variables.

^{\$} Omitted reference group.

Note: For men from wave 1 to 2: driving after 3+ drinks (No. days driving after having 3+ drinks) -- 15.7% decreased, 15.5% increased; drive after drinking too much, 4.2% decreased; 5.9% increased; drinking while driving -- 6.0% decreased; 6.2% increased. For women from wave 1 to 2: driving after 3+ drinks -- 7.0% decreased, 7.0% increased; drive after drinking too much -- 1.9% decreased, 2.5% increased; drinking while driving -- 3.0% decreased, 3.0% increased.

Table 2.

The Relationship of Depression and Alcohol-Impaired Driving in NESARC Wave 1

Specification		No. days driving after having 3+ drinks	Driving after drinking too much	Drinking while driving
Panel A: Males				
I	Major depression	3.959 ** (1.533)	0.031 *** (0.010)	0.029 (0.015)
II	Major depression	2.341 (2.229)	0.030 *** (0.010)	0.027 (0.015)
	Binge drinker	15.422 *** (2.074)	0.138 *** (0.011)	0.185 *** (0.011)
III	Major depression	-0.512 (2.723)	0.008 (0.009)	-0.001 (0.014)
	Non-AD binge drinker	14.511 *** (2.110)	0.126 *** (0.012)	0.167 *** (0.011)
	Alcohol dependence	24.678 *** (3.269)	0.216 *** (0.013)	0.284 *** (0.014)
N		8,561	8,633	8,633
Panel B: Females				
I	Major depression	0.809 (1.077)	0.018 *** (0.005)	0.024 *** (0.006)
II	Major depression	0.219 (1.186)	0.016 *** (0.004)	0.021 *** (0.006)
	Binge drinker	3.097 *** (0.950)	0.068 *** (0.007)	0.077 *** (0.007)
III	Major depression	-0.792 (1.263)	0.007 (0.004)	0.011 (0.006)
	Non-AD binge drinker	1.504 (0.829)	0.057 *** (0.007)	0.065 *** (0.007)
	Alcohol dependence	7.267 *** (1.577)	0.098 *** (0.008)	0.119 *** (0.009)
N		9,839	9,872	9,872
Model		Negative Binomial	Logit	Logit

p<0.001;**
p<0.01;*
p<0.05

Regressions include respondent attribute covariates described in Table 1, Panel A.

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Table 3.

Changes in Depression, AUDs, and the Frequency of Driving After Having 3+ Drinks Between Waves

VARIABLES	Specification								
	I			II			III		
	Decreased	No	Increased	Decreased	No	Increased	Decreased	No	Increased
Panel A: Males (n=8,539)									
Major Depression									
Onset	-0.078 *** (0.023)	0.000 (0.003)	0.078 *** (0.023)	-0.074 *** (0.023)	0.000 (0.003)	0.074 *** (0.022)	-0.064 ** (0.023)	0.000 (0.002)	0.064 ** (0.023)
Continuing	0.021 (0.043)	0.000 (0.001)	-0.021 (0.043)	0.027 (0.044)	0.000 (0.001)	-0.027 (0.044)	0.026 (0.042)	0.000 (0.001)	-0.026 (0.042)
Recovery	0.021 (0.023)	0.000 (0.001)	-0.021 (0.023)	0.015 (0.023)	0.000 (0.001)	-0.015 (0.022)	0.008 (0.022)	0.000 (0.000)	-0.008 (0.021)
Binge drinker				-0.104 *** (0.007)	0.000 (0.004)	0.104 *** (0.007)			
Non-AD binge drinker							-0.098 *** (0.007)	0.000 (0.003)	0.098 *** (0.008)
Alcohol dependence							-0.198 *** (0.017)	0.001 (0.007)	0.197 *** (0.017)
Panel B: Females (n=9,833)									
Major Depression									
Onset	-0.021 ** (0.010)	0.000 (0.001)	0.021 ** (0.010)	-0.017 (0.010)	0.000 (0.001)	0.017 (0.010)	-0.010 (0.009)	0.000 (0.001)	0.010 (0.009)
Continuing	0.005 (0.014)	0.000 (0.000)	-0.005 (0.014)	0.002 (0.015)	0.000 (0.000)	-0.002 (0.015)	0.002 (0.014)	0.000 (0.000)	-0.002 (0.014)
Recovery	0.010 (0.009)	0.000 (0.001)	-0.010 (0.009)	0.009 (0.009)	0.000 (0.001)	-0.009 (0.009)	0.006 (0.009)	0.000 (0.000)	-0.006 (0.009)
Binge drinker				-0.063 *** (0.005)	0.000 (0.004)	0.063 *** (0.006)			
Non-AD binge drinker							-0.055 *** (0.005)	0.000 (0.003)	0.054 *** (0.005)
Alcohol dependence							-0.141 *** (0.013)	0.001 (0.008)	0.140 *** (0.012)

p<0.001;**
p<0.01;*
p<0.05

Marginal effects and standard errors shown.

Regressions include respondent attribute covariates described in Table 1, Panel B.

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Table 4.

Changes in Depression, AUDs, and the Probability of Driving After Drinking “Too Much” Between Waves

	Specification								
	I			II			III		
	Decreased	No	Increased	Decreased	No	Increased	Decreased	No	Increased
Panel A: Males (n=8,633)									
Major Depression									
Onset	-0.021 [*]	-0.008	0.030 [*]	-0.020	-0.007	0.028	-0.010	-0.004	0.014
	(0.011)	(0.005)	(0.015)	(0.010)	(0.004)	(0.015)	(0.010)	(0.004)	(0.014)
Continuing	0.010	0.004	-0.013	0.011	0.004	-0.015	0.011	0.004	-0.014
	(0.019)	(0.007)	(0.027)	(0.019)	(0.007)	(0.026)	(0.018)	(0.006)	(0.024)
Recovery	0.022 ^{**}	0.008 [*]	-0.030 ^{**}	0.021 [*]	0.008 [*]	-0.029 [*]	0.015 [*]	0.005	-0.021 [*]
	(0.009)	(0.004)	(0.012)	(0.009)	(0.004)	(0.012)	(0.007)	(0.003)	(0.010)
Binge drinker				-0.026 ^{***}	-0.010 [*]	0.036 ^{***}			
				(0.003)	(0.002)	(0.004)			
Non-AD binge drinker							-0.021 ^{***}	-0.007 ^{***}	0.028 ^{***}
							(0.003)	(0.002)	(0.004)
Alcohol dependence							-0.084 ^{***}	-0.030 ^{***}	0.114 ^{***}
							(0.008)	(0.007)	(0.009)
Panel B: Females (n=9,872)									
Major Depression									
Onset	-0.012 ^{**}	-0.005	0.018 ^{**}	-0.011 ^{**}	-0.005	0.016 [*]	-0.007	-0.003	0.009
	(0.004)	(0.003)	(0.007)	(0.004)	(0.003)	(0.007)	(0.004)	(0.002)	(0.006)
Continuing	0.004	0.002	-0.006	0.004	0.002	-0.005	0.004	0.002	-0.006
	(0.009)	(0.004)	(0.012)	(0.009)	(0.004)	(0.012)	(0.007)	(0.003)	(0.010)
Recovery	0.005	0.002	-0.007	0.004	0.002	-0.006	0.002	0.001	-0.003
	(0.005)	(0.002)	(0.007)	(0.005)	(0.002)	(0.007)	(0.004)	(0.002)	(0.006)
Binge drinker				-0.015 ^{***}	-0.007 ^{**}	0.022 ^{***}			
				(0.002)	(0.002)	(0.004)			
Non-AD binge drinker							-0.011 ^{***}	-0.004 [*]	0.015 ^{***}
							(0.002)	(0.002)	(0.003)
Alcohol dependence							-0.048 ^{***}	-0.020 ^{**}	0.068 ^{***}
							(0.005)	(0.006)	(0.006)

p<0.001;**
p<0.01;*
p<0.05

Marginal effects and standard errors shown.

Regressions include respondent attribute covariates described in Table 1, Panel B.

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Table 5.

Changes in Depression, AUDs, and the Probability of Drinking While Driving Between Waves

	Specification								
	I			II			III		
	Decreased	No	Increased	Decreased	No	Increased	Decreased	No	Increased
Panel A: Males (n=8,633)									
Major Depression									
Onset	−0.002 (0.013)	0.000 (0.001)	0.002 (0.012)	0.000 (0.012)	0.000 (0.001)	0.000 (0.011)	0.010 (0.011)	−0.001 (0.001)	−0.010 (0.011)
Continuing	0.004 (0.022)	0.000 (0.001)	−0.004 (0.021)	0.006 (0.022)	0.000 (0.001)	−0.005 (0.021)	0.005 (0.020)	0.000 (0.001)	−0.005 (0.019)
Recovery	0.031 ** (0.012)	−0.002 (0.002)	−0.029 ** (0.011)	0.029 * (0.012)	−0.001 (0.002)	−0.028 * (0.011)	0.021 (0.011)	−0.001 (0.001)	−0.020 (0.010)
Binge drinker				−0.039 *** (0.004)	0.002 (0.003)	0.037 *** (0.004)			
Non-AD binge drinker							−0.032 *** (0.004)	0.002 (0.002)	0.031 *** (0.004)
Alcohol dependence							−0.117 *** (0.010)	0.006 (0.008)	0.110 *** (0.008)
Panel B: Females (n=9,872)									
Major Depression									
Onset	−0.010 (0.008)	0.000 (0.001)	0.010 (0.008)	−0.009 (0.007)	0.000 (0.001)	0.009 (0.008)	−0.003 (0.006)	0.000 (0.000)	0.003 (0.006)
Continuing	0.009 (0.010)	0.000 (0.001)	−0.009 (0.010)	0.008 (0.010)	0.000 (0.001)	−0.007 (0.010)	0.008 (0.009)	0.000 (0.001)	−0.007 (0.009)
Recovery	0.013 (0.007)	0.000 (0.001)	−0.013 (0.007)	0.012 (0.007)	0.000 (0.001)	−0.012 (0.007)	0.008 (0.006)	0.000 (0.001)	−0.008 (0.006)
Binge drinker				−0.024 *** (0.003)	0.000 (0.002)	0.023 *** (0.003)			
Non-AD binge drinker							−0.017 *** (0.003)	0.000 (0.002)	0.017 *** (0.003)
Alcohol dependence							−0.072 *** (0.006)	0.002 (0.007)	0.071 *** (0.007)

p<0.001;**
p<0.01;*
p<0.05

Marginal effects and standard errors shown.

Regressions include respondent attribute covariates described in Table 1, Panel B.